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AQA

Please write clearly in block capitals.

Centre number | | | | | | Candidate number | | | | |

Surname _____

Forename(s) _____

Candidate signature _____

GCSE CHEMISTRY

H

Higher Tier Paper 2

Wednesday 12 June 2019 Morning Time allowed: 1 hour 45 minutes

Materials

For this paper you must have:
- a ruler
- a scientific calculator
- the periodic table (enclosed).

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- Do all rough work in this book. Cross through any work you do not want to be marked.
- In all calculations, show clearly how you work out your answer.

Information
- The maximum mark for this paper is 100.
- The marks for questions are shown in brackets.
- You are expected to use a calculator where appropriate.
- You are reminded of the need for good English and clear presentation in your answers.

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
TOTAL	

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Answer **all** questions in the spaces provided.

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0 1 This question is about crude oil and hydrocarbons.

Figure 1 shows a fractionating column used to separate crude oil into fractions.

Figure 1

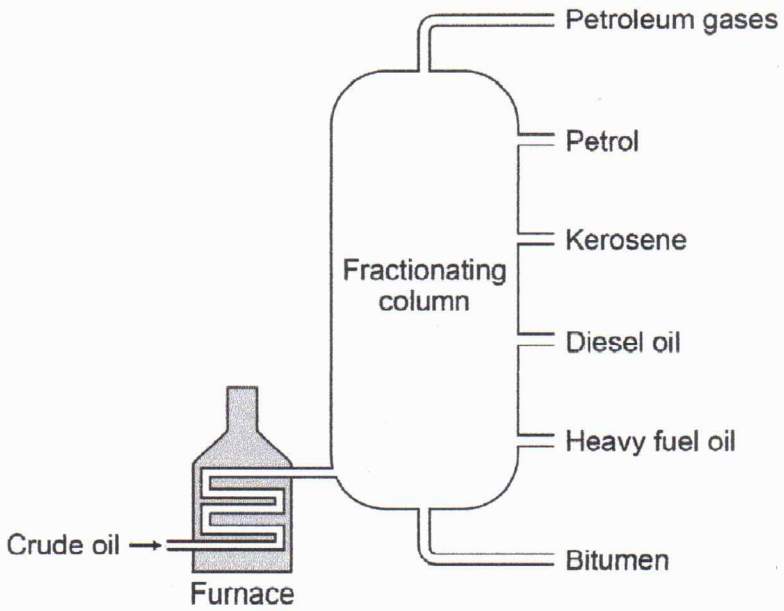

Table 1 gives information about some of the fractions.

Table 1

Fraction	Boiling point range in °C
Petroleum gases	Below 30
Petrol	40–110
Kerosene	180–260
Diesel oil	260–320
Heavy fuel oil	320–400
Bitumen	400–450

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0 1 . 1 Suggest a suitable temperature for the furnace in **Figure 1**.

[1 mark]

500 °C

0 1 . 2 Explain why diesel oil collects above heavy fuel oil but below kerosene in the fractionating column.

Use **Table 1**.

[2 marks]

Diesel oil has a lower boiling point than heavy fuel oil but higher boiling point than kerosene.

0 1 . 3 Suggest **two** reasons why bitumen is **not** used as a fuel.

[2 marks]

1 The boiling point of bitumen is too high.

2 Bitumen is not very flammable thus it is difficulty to burn or ignite.

Question 1 continues on the next page

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0 1 . 4 Petrol contains mainly alkanes.

Which of the following compounds is an alkane?

[1 mark]

Tick (✓) **one** box.

C_2H_4	☐	- alkene
C_4H_8	☐	- alkene
C_6H_{14}	✓	
C_8H_{16}	☐	- alkene

alkenes have general formula C_nH_{2n+2}

Large hydrocarbon molecules in the diesel oil fraction are cracked to produce smaller hydrocarbon molecules.

0 1 . 5 Describe the conditions needed to crack hydrocarbon molecules from the diesel oil fraction.

[2 marks]

For cracking it requires high temperature about 600 - 800°C and catalyst to speed up the reaction such as aluminium oxide.

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Do not write outside the box

0 1 . 6 Explain why large hydrocarbon molecules in the diesel oil fraction are cracked to produce smaller hydrocarbon molecules.

[2 marks]

Large hydrocarbon are being cracked to smaller molecules due to the more demand as shorter chained molecules are better fuels. They are also required to make polymers.

0 1 . 7 Complete the equation for the cracking of $C_{15}H_{32}$

[1 mark]

$$C_{15}H_{32} \rightarrow C_{12}H_{26} + C_3H_6$$

11

Turn over for the next question

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0 2 This question is about lithium carbonate.

Lithium carbonate is used in medicines.

Figure 2 shows a tablet containing lithium carbonate.

Figure 2

0 2 . 1 Lithium carbonate contains lithium ions and carbonate ions.

A student tested the tablet for lithium ions and for carbonate ions.

The student used:

- a metal wire
- dilute hydrochloric acid
- limewater.

Plan an investigation to show the presence of lithium ions **and** of carbonate ions in the tablet.

You should include the results of the tests for the ions.

[6 marks]

You are required to add the dilute hydrochloric acid to the tablet. There will be fizzing (effervescence) that occurs. The bubbles seen, indicates a gas that is produced. You then bubble the gas produced in the lime water. The lime water turns cloudy or Milky

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Confirming Carbondioxide is present. Thus the Carbonate ions Present.

For the lithium ions, it is required to clean the nichrome wire by dipping it in hydrochloric acid and holding it over a bunsen burner flame until it turns without colour. Then dip the wire loop in the sample and hold it over the flame, It will burn in a blue flame, then a crimson flame is seen.

0 2 . 2 The tablet also contains other substances.

The substances in tablets are present in fixed amounts.

What name is given to mixtures like tablets?

[1 mark]

Formulation

0 2 . 3 The tablet has a mass of 1.20 g and contains 700 mg of lithium carbonate.

Calculate the percentage by mass of lithium carbonate in this tablet.

[3 marks]

1·20g Contains 700mg Lithium Carbonate.

1000mg = 1g

∴ 1·2g

1·2×1000 = 1200mg

Percentage Mass = $\frac{700}{1200} \times 100\%$

$= 58.333\%$

≈ 58.3

Percentage by mass of lithium carbonate = 58·3 %

10

Turn over ▶

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0 3 This question is about rate of reaction.

A student investigated the rate of the reaction between magnesium and dilute hydrochloric acid.

The equation for the reaction is:

$$Mg(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$$

0 3 . 1 Which state symbol in the equation for the reaction does **not** represent one of the three states of matter?

[1 mark]

aq

The student determined the rate of production of hydrogen gas.

0 3 . 2 What **two** pieces of measuring apparatus could the student use to find the rate of production of hydrogen gas?

[2 marks]

1 Use of a gas syringe.

2 Use of a stop watch.

Question 3 continues on the next page

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Table 2 shows the results of the investigation.

Table 2

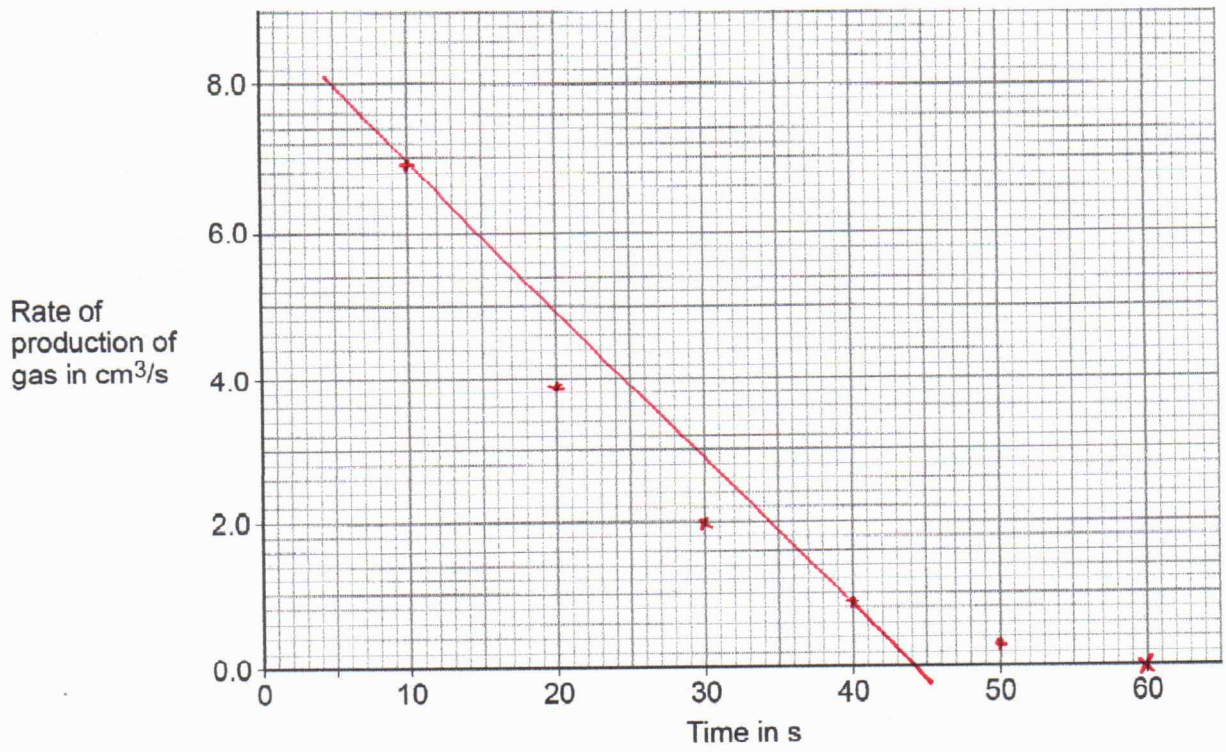
Time in s	Rate of production of gas in cm^3/s
10	6.9
20	3.9
30	2.0
40	0.9
50	0.3
60	0.0

0 3 . 3 Plot the data from **Table 2** on **Figure 3**.

You should draw a line of best fit.

[3 marks]

Figure 3



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0 3 . 4 Give **three** conclusions that can be drawn about the rate of reaction between magnesium and dilute hydrochloric acid in this investigation.

Use data from **Figure 3** and **Table 2**.

[3 marks]

1 When time increases the rate of production of the gas decreases.

2 When the time is at highest (60 seconds) the rate of production is zero.

3 The rate of the reaction decreases at a non-linear rate.

0 3 . 5 The student repeated the investigation using dilute hydrochloric acid at a higher temperature.

All the other variables were kept the same.

Which **two** statements are correct?

[2 marks]

Tick (✓) **two** boxes.

More bubbles were produced in the first 10 seconds.	✓
The activation energy for the reaction was higher.	
The magnesium was used up more quickly.	✓
The reaction finished at the same time.	
The total volume of gas collected was greater.	

11

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0 4 This question is about the corrosion of metals.

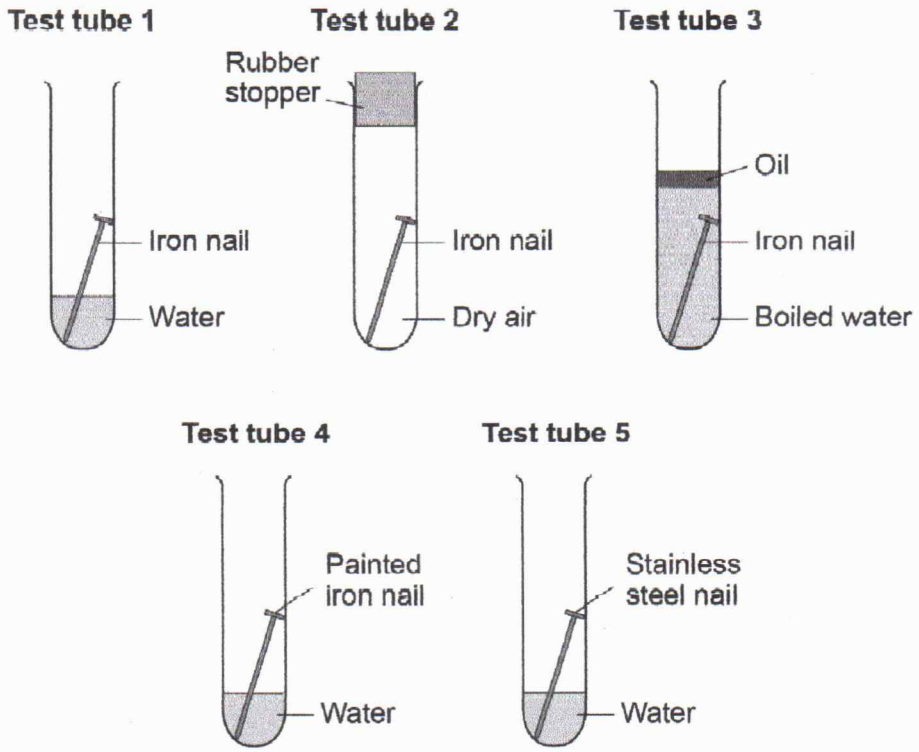
The corrosion of iron is called rusting.

0 4 . 1 A student investigated the rusting of iron.

This is the method used.

1. Set up the test tubes as shown in **Figure 4**.
2. Leave the test tubes for 1 week.
3. Examine the nails for signs of rust.

Figure 4



Explain what would happen to the nails in each of the test tubes.

[5 marks]

Tube 1:→ The nails in Tube 1 will rust because oxygen and water is present.

Tube 2; The nail does not rust because there is no water present, thus

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Rust Cannot occur Without Moisture/Water.

Tube 3; Nail does not rust because oxygen is not present.

Tube 4; Nail does not rust because Paint is a barrier to oxygen. Tube 5 Nail does not rust because Stainless steel is resistant to Corrosion.

0 4 . 2 Magnesium is fixed to some steel ships.

Explain how this prevents the steel from rusting.

[2 marks]

Magnesium is more reactive than iron, ~~therefore~~ Magnesium provides a sacrifical Protection, thus steel Cannot rust.

0 4 . 3 Explain why aluminium window frames do **not** corrode after they are made.

[2 marks]

Aluminium has a coating of aluminium oxide, so the aluminium oxide Protects the metal from further corrosion.

9

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0 5 This question is about combustion of fuels.

0 5 . 1 Some central heating boilers use wood as a fuel.

Suggest **two** reasons why wood is more sustainable than natural gas as a fuel for central heating boilers.

[2 marks]

1 Wood is a renewable resource while the natural gas is finite.

2 Burning wood produces the same amount of Carbardioxide as the trees absabed but natural gas Increases the amount of Carbardioxide in the atmosphere.

Natural gas is mainly methane.

When methane burns it can produce both carbon monoxide and carbon dioxide.

0 5 . 2 Explain the process by which carbon monoxide can be produced when methane is burned.

[2 marks]

Carbon Monoxide would be produced when Methane burns in insufficient supply of oxygen. The Carbonmonoxide is produced thus an Incomplete Combustion.

0 5 . 3 Balance the equation for the combustion of methane to produce carbon monoxide.

[1 mark]

$$2\ CH_4(g) + 3\ O_2(g) \rightarrow 2\ CO(g) + 4\ H_2O(l)$$

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Do not write outside the box

0 5 . 4 Propane burns to form carbon dioxide and water.

The equation for the reaction is:

$$C_3H_8(g) + 5O_2(g) \rightarrow 3CO_2(g) + 4H_2O(l)$$

3.60 dm^3 carbon dioxide is produced when a sample of propane is burned in 7.25 dm^3 oxygen.

Calculate the volume of unreacted oxygen.

Give your answer in cm^3

[4 marks]

Using Mole ratio of O_2 : CO_2

5 : 3.

Oxygen needed = $\frac{3.60 \times 5}{3}$

= 6.0 dm^3

Amount of oxygen Unreacted = 7.25 − 6.0

= 1.25 dm^3

Volume of Unreacted oxygen = 1.25 × 1000

1000 cm^3 = 1 dm^3 = 1250 cm^3

Volume of unreacted oxygen = 1250 cm^3

9

Turn over for the next question

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0 6 **Figure 5** shows a surfer on a surfboard.

Figure 5

Surfboards are made from polymers.

Surfboards have a poly(styrene) core and an outer skin.

0 6 . 1 **Figure 6** shows the displayed structural formula of poly(styrene).

Figure 6

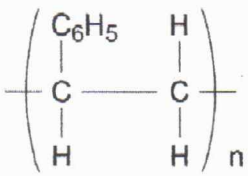
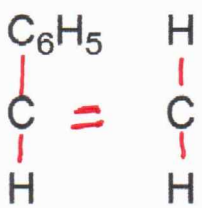


Figure 7 shows an incomplete displayed structural formula of the monomer styrene.

Complete **Figure 7**.

[2 marks]

Figure 7



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The outer skin of surfboards contains a polyester.

Two monomers, **A** and **B**, are needed to make the polyester.

Figure 8 shows how these two monomers are represented.

Figure 8

Monomer **A** Monomer **B**

0 6 . 2 Name the functional group in monomer **B**.

[1 mark]

Carboxylic acid group.

0 6 . 3 Monomers **A** and **B** join together to produce a polyester and a small molecule.

Name the small molecule.

[1 mark]

Water

0 6 . 4 Why does this type of polyester melt when it is heated?

[2 marks]

The Polyster Melts because it is thermosoftening or it is thermoplastic and it has no cross-links, thus its intermolecular forces are weak.

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Do not write outside the box

The outer skin of surfboards is a composite material.

The composite material contains glass fibres surrounded by a polyester.

0 6 . 5 Draw **one** line from each material to the description of that material.

[2 marks]

Material	Description of the material
Glass fibres	Matrix
Polyester	Reinforcement
	Hydrocarbon
	Monomer
	Polypeptide

0 6 . 6 The outer skin makes the surfboard more expensive.

Suggest **two** reasons why an outer skin is added to the poly(styrene) core.

[2 marks]

1 The outer skin makes the surfboard more harder and strong.

2 The surfboard will be more tougher and rigid.

10

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0 7 A large amount of aluminium sulfate was accidentally added to the drinking water supply at a water treatment works.

0 7 . 1 Describe a test to show that the drinking water contained aluminium ions.

Give the result of the test.

[3 marks]

Test You are required to add sodium hydroxide solution to water sample.

Result A white precipitate forms which it is soluble in excess.

0 7 . 2 Describe a test to show that the drinking water contained sulfate ions.

Give the result of the test.

[2 marks]

Test You are required to add barium chloride solution to dilute hydrochloric acid to water sample.

Result A white precipitate is formed.

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0 7 . 3 Plan an investigation to find the total mass of dissolved solids in a 100 cm^3 sample of the drinking water.

Your investigation should produce valid results.

[4 marks]

You are required to weigh a container using a balance. Measure 100 cm^3 of water into the container. Heat the water until it has all evaporated. Take away the mass of the empty container from the total mass. This is the mass of the dissolved solids in the river water.

You can repeat heating until constant mass is obtained.

9

Turn over for the next question

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0 8 Titan is a moon of the planet Saturn.

Table 3 shows the percentages of the gases in the atmosphere of Titan.

Table 3

Gas	Percentage of gas in atmosphere (%)
Nitrogen	98.4
Methane	1.4
Other gases	0.2

0 8 . 1 Some scientists think that living organisms could have evolved on Titan.

Explain why these organisms could **not** have evolved in the same way that life is thought to have evolved on Earth.

Use **Table 3**.

[3 marks]

Titan had little or no oxygen so photosynthesis did not occur, therefore no Carbondioxide present. This is to show that oxygen-using animals cannot have evolved on titan. No plants therefore no oxygen is produced.

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Do not write outside the box

0 8 . 2 Saturn has other moons.

The other moons of Saturn have no atmosphere.

Titan is warmer than the other moons of Saturn because its atmosphere contains the greenhouse gas methane.

Explain how this greenhouse gas keeps Titan warmer than the other moons of Saturn.

[3 marks]

Methane allows shorter wavelength radiation to pass through the sun which is re-emitted from the surface as longer wavelength radiation which is absorbed by methane in the atmosphere.

0 8 . 3 The atmosphere of Titan contains small amounts of propene.

Describe a test to show that propene is an unsaturated hydrocarbon.

Give the result of the test.

[2 marks]

Test Add bromine water

Result Bromine water changes from orange to colourless.

8

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0 9 Some students investigated the rate of decomposition of hydrogen peroxide, H_2O_2

The equation for the reaction is:

$$2H_2O_2(aq) \rightarrow 2H_2O(l) + O_2(g)$$

The catalyst for the reaction is manganese dioxide.

0 9 . 1 Describe a test to identify the gas produced in the reaction.

Give the result of the test.

[2 marks]

Test Place a glowing splint inside a test tube Containing oxygen.

Result If the gas is oxygen the splint will relight.

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Student **A** investigated the effect of the particle size of manganese dioxide on the rate of the reaction.

This is the method used.

1. Measure 25 cm^3 of 0.3 mol/dm^3 hydrogen peroxide solution into a conical flask.

2. Add a spatula of fine manganese dioxide powder to the conical flask.

3. Measure the volume of gas produced every minute for 10 minutes.

4. Repeat steps 1 to 3 with some coarse manganese dioxide lumps.

0 9 . 2 The method student **A** used did **not** give valid results.

What **two** improvements could student **A** make to the method to give valid results?

[2 marks]

Tick (✓) **two** boxes.

Measure the increase in mass of the conical flask and contents.	
Measure the volume of gas produced every 2 minutes.	
Place the conical flask in a water bath at constant temperature.	✓
Use 0.05 mol/dm^3 hydrogen peroxide solution.	
Use a mass of 1 g manganese dioxide each time.	✓

Question 9 continues on the next page

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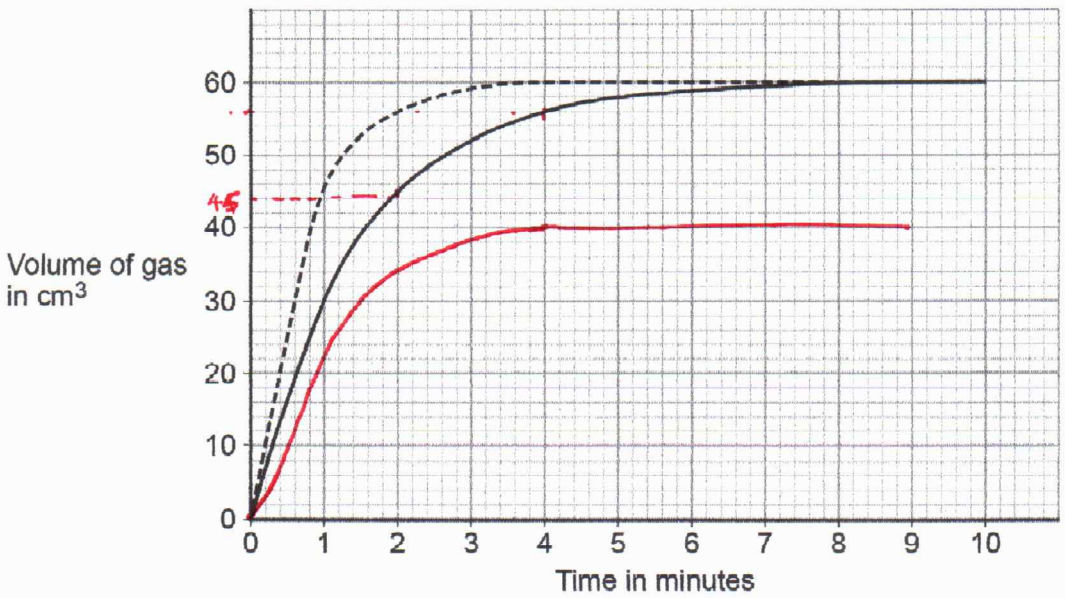
Student **B** used a method which gave valid results.

Figure 9 shows student **B**'s results.

Figure 9



0 9 . 3 Determine the mean rate of reaction in cm^3/s between 2 and 4 minutes for coarse manganese dioxide lumps.

Give your answer to 2 significant figures.

Use data from **Figure 9**.

[3 marks]

Time taken = 2 minutes equivalent to 120 seconds.

Volume of gas = $56cm^3 - 45cm^3$
= $11 cm^3$

Mean rate of reaction = $11/120 = 0.09167$
$\approx 0.092 cm^3/s$

Mean rate of reaction = 0.092 cm^3/s

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Hydrogen peroxide molecules must collide with manganese dioxide particles for catalysis to take place.

0 9 . 4 Student **B** repeated the experiment with coarse lumps of manganese dioxide.

Student **B** used the same volume of 0.2 mol/dm^3 hydrogen peroxide instead of 0.3 mol/dm^3 hydrogen peroxide.

Sketch on **Figure 9** the curve you would expect to see.

Assume that the reaction is complete after 9 minutes.

[2 marks]

0 9 . 5 The rate of reaction is different when manganese dioxide is used as a fine powder rather than coarse lumps.

Explain why.

You should answer in terms of collision theory.

[2 marks]

The surface area of the fine manganese dioxide powder is greater because more collisions will occur with the hydrogen peroxide molecules per unit time.

11

Turn over for the next question

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1 0 This question is about reversible reactions and equilibrium.

Hydrogen is used to produce ammonia in the Haber process.

The hydrogen is made in two stages.

Stage 1 is the reaction of methane and steam to produce carbon monoxide and hydrogen.

The equation for the reaction is:

$$CH_4(g) + H_2O(g) \rightleftharpoons CO(g) + 3H_2(g)$$

1 0 . 1 Calculate the atom economy for the formation of hydrogen in **stage 1**.

Relative atomic masses (A_r): H = 1 C = 12 O = 16

[2 marks]

Atom economy = total M_r of desired Product / total M_r of all reactants $\times 100\%$

$3H_2 = 6$

$= \frac{6}{34} \times 100\%$

$= 17.64705882$

≈ 17.6

Atom economy = 17.6 %

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10.2 Explain why a low pressure is used in **stage 1**.

Give your answer in terms of equilibrium.

[2 marks]

Low pressure is required for a higher yield of hydrogen because fewer moleules are on left hand side. The equilibrium moves to the right in the forward direction.

10.3 **Stage 2** uses the carbon monoxide produced in **stage 1**.

The carbon monoxide is reacted with more steam to produce carbon dioxide and more hydrogen.

The equation for the reaction in **stage 2** is:

$$CO(g) + H_2O(g) \rightleftharpoons CO_2(g) + H_2(g)$$

What is the effect of increasing the pressure on the equilibrium yield of hydrogen in **stage 2**?

[1 mark]

There will be no effect on yield of hydrogen.

Question 10 continues on the next page

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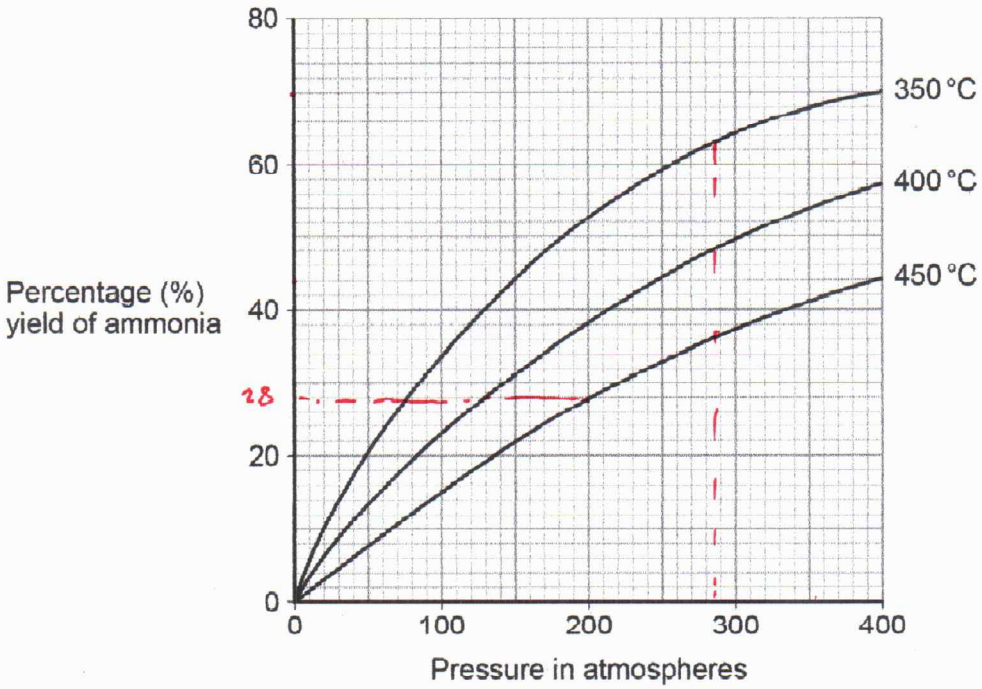
Figure 10 shows the percentage yield of ammonia produced at different temperatures and pressures in the Haber process.

Figure 10



A temperature of 450 °C and a pressure of 200 atmospheres are used in the Haber process.

10.4 A student suggested that a temperature of 350 °C and a pressure of 285 atmospheres could be used instead of those used in the Haber process.

Determine how many times greater the percentage yield of ammonia obtained would be.

Use **Figure 10**.

[3 marks]

Using 350°C and 285 atmospheres the Percentage of NH_3 is 63%.

For 450°C and 200 atmospheres Percentage of NH_3 is 28%

Many times = $\frac{63}{28}$ = 2.25 greater

Percentage yield = 2.25 times greater

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1 0 . 5 A pressure of 285 atmospheres is **not** used in the Haber process instead of 200 atmospheres.

Give **one** reason why.

[1 mark]

The energy costs would be higher, and the equipment would need to be stronger.

1 0 . 6 How does **Figure 10** show that the forward reaction in the Haber process is exothermic?

[1 mark]

When the temperature is high, it produces a lower percentage yield of the ammonia.

1 0 . 7 World production of ammonia is now about 30 times greater than it was in 1950.

Suggest why the demand for ammonia has increased.

[2 marks]

Ammonia demand has increased due to high demand of fertilisers and also because of ammonia based products such as drugs, dyes and explosives.

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END OF QUESTIONS